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(54)【発明の名称】　耐水素遅れ割れ特性に優れた高張力電縫鋼管の製造方法

(57)【特許請求の範囲】
【請求項１】　ｗｔ％で、Ｃ：０．１～０．１９、Ｓｉ：０．０１～０．５、Ｍｎ：０．８～１．６、Ｃｒ：０．０５～０．６、Ａｌ：０．０１～０．０６、Ｐ：０．０２以下（０を含む）、Ｓ：０．００３以下（０を含む）、Ｎ：０．００５以下（０を含む）、Ｔｉ：０．０１５以下（０を含む）、Ｂ：０．０００５～０．００３で、かつＢ量を式（１）を満足するように調整した組成を有し、
$B^* \geqq 0.0005$　（１）
ただし、$N \geqq (14/48)Ti$のとき
$B^* = B - (11/14)N + (11/48)Ti$
$N < (14/48)Ti$のとき
$B^* = B$
残部が実質的にＦｅおよび不可避的不純物からなる鋼の

スラブを熱間圧延するにあたり、前記鋼のＡｒ，変態点の温度をＴＡｒ，としたとき、仕上温度Ｔｆが（ＴＡｒ，＋３０）～（ＴＡｒ，＋１００）℃の温度範囲になるように仕上温度Ｔｆを制御して熱間圧延し、かつそのとき３０％以上の圧下率をＴｆ～（Ｔｆ＋３０）℃の温度範囲で与えて熱間圧延し、熱間圧延後直ちに６０～２００℃／ｓの冷却速度で１５０～２５０℃の温度範囲にある温度Ｔｃまで冷却後、１５０℃以上前記Ｔｃ以下の温度範囲に２秒以上滞留させ、１５０℃未満の温度で巻取って熱延鋼板を作製し、前記熱延鋼板を用いて式（２）を満たす縮絞り率Ｑで造管することを特徴とする耐水素遅れ割れ特性に優れた高張力電縫鋼管の製造方法。
$1000 \leqq Q/(t/D)^2 \leqq 3000$　（２）
ここで、ｔ（ｍｍ）は熱延鋼板の板厚、Ｄ（ｍｍ）は電縫鋼管の外径、Ｑ（％）は縮絞り率で、式（３）で定義

される。

$$Q=\{(\text{鋼板の幅}-\pi(D-t))/\pi(D-t)\}\times 100 \quad (3)$$

【請求項２】　鋼スラブがｗｔ％で、Ｎｂ：０．００５～０．０３、Ｖ：０．００５～０．０３のうち少なくとも１種以上を含有することを特徴とする請求項１に記載の耐水素遅れ割れ特性に優れた高張力電縫鋼管の製造方法。

【請求項３】　鋼スラブがｗｔ％で、Ｃｕ：０．０５～０．５を含有することを特徴とする請求項１または２に記載の耐水素遅れ割れ特性に優れた高張力電縫鋼管の製造方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、自動車のドアインパクトビームなどに用いられる高張力電縫鋼管の製造方法に関する。

【０００２】

【従来の技術】自動車などの車両ドア内部には、安全性の観点からドアインパクトビームと呼ばれる補強材が設けられている。従来のドアインパクトビームには、高張力冷延鋼板のプレス成形品が用いられることが多かったが、近年、軽量化のために、引張強度が９８０Ｎ／ｍｍ^2 以上の著しく強度の高い高張力電縫鋼管が採用されるようになってきた。

【０００３】しかし、著しく強度が高く、しかも造管により残留歪みが付加される高張力電縫鋼管をドアインパクトビームに用いる場合、ドア内部で腐食が進行すると鋼中に水素が侵入し鋼が破壊されるいわゆる「水素遅れ割れ」が生じる恐れがある。

【０００４】これまで、著しく強度の高い熱延鋼板や冷延鋼板を用いた高張力電縫鋼管やその製造方法については、特開平１－２０５０３２号公報、特開平４－１３１３２７号公報、特開平４－１８７３１９号公報、特開平６－８８１２９号公報などで紹介されている。

【０００５】

【発明が解決しようとする課題】しかしながら、いずれも「水素遅れ割れ」に対する考慮がなされていない。

【０００６】本発明は、このような課題を解決するためになされたものであり、引張強度が９８０Ｎ／ｍｍ^2 以上で、しかも耐水素遅れ割れ特性に優れた高張力電縫鋼管の製造方法を提供することを目的とする。

＊

$$Q=\{(\text{鋼板の幅}-\pi(D-t))/\pi(D-t)\}\times 100 \quad (3)$$

鋼の成分限定理由を以下に説明する。

【００１１】Ｃ：マルテンサイト生成元素であり、かつマルテンサイトの硬さを高める元素であるので、目標とする強度を確保するために必須な元素である。添加量が０．１ｗｔ％未満であると，目標とする９８０Ｎ／ｍｍ^2 以上の強度が得られない。添加量が０．１９ｗｔ％を超えると、耐水素遅れ割れ特性が劣化する。

【００１２】Ｓｉ：電縫溶接部の健全性を確保するため

＊【０００７】

【課題を解決するための手段】本発明者等は、耐水素遅れ割れ特性に優れた高張力電縫鋼管の製造方法について鋭意検討した結果、鋼成分、熱延条件および造管条件を適性化することにより上記課題が解決されるという知見を見出した。

【０００８】すなわち、請求項１に記載の第１の発明は、ｗｔ％で、Ｃ：０．１～０．１９、Ｓｉ：０．０１～０．５、Ｍｎ：０．８～１．６、Ｃｒ：０．０５～０．６、Ａｌ：０．０１～０．０６、Ｐ：０．０２以下（０を含む）、Ｓ：０．００３以下（０を含む）、Ｎ：０．００５以下（０を含む）、Ｔｉ：０．０１５以下（０を含む）、Ｂ：０．０００５～０．００３で、かつＢ量を式（１）を満足するように調整した組成を有し、

$$B^* \geqq 0.0005 \quad (1)$$

ただし、Ｎ≧（１４／４８）Ｔｉのとき

$B^* = B-(11/14)N+(11/48)Ti$

Ｎ＜（１４／４８）Ｔｉのとき

$B^* = B$

残部が実質的にＦｅおよび不可避的不純物からなる鋼のスラブを熱間圧延するにあたり、前記鋼のＡｒ$_3$ 変態点の温度をＴＡｒ$_3$ としたとき、仕上温度Ｔｆが（ＴＡｒ$_3$ ＋３０）～（ＴＡｒ$_3$ ＋１００）℃の温度範囲になるように仕上げ温度Ｔｆを制御して熱間圧延し、かつそのとき３０％以上の圧下率をＴｆ～（Ｔｆ＋３０）℃の温度範囲で与えて熱間圧延し、熱間圧延後直ちに６０～２００℃／ｓの冷却速度で１５０～２５０℃の温度範囲にある温度Ｔｃまで冷却後、１５０℃以上前記Ｔｃ以下の温度範囲に２秒以上滞留させ、１５０℃未満の温度で巻取って熱延鋼板を作製し、前記熱延鋼板を用いて式（２）を満たす幅絞り率Ｑで造管することを特徴とする耐水素遅れ割れ特性に優れた高張力電縫鋼管の製造方法に関するものである。

【０００９】

$$1000 \leqq Q/(t/D)^2 \leqq 3000 \quad (2)$$

ここで、ｔ（ｍｍ）は熱延鋼板の板厚、Ｄ（ｍｍ）は電縫鋼管の外径、Ｑ（％）は幅絞り率で、式（３）で定義される。

【００１０】

$$Q=\{(\text{鋼板の幅}-\pi(D-t))/\pi(D-t)\}\times 100 \quad (3)$$

に添加する必要があり、添加量が０．０１～０．５ｗｔ％の範囲で電縫溶接部の健全性が良好となる。

【００１３】Ｍｎ：オーステナイトの焼入れ性を上げ、マルテンサイトを生成させ、目標とする強度を確保するために必須な元素である。添加量が０．８ｗｔ％未満であると目標とする９８０Ｎ／ｍｍ^2 以上の強度が得られない。添加量が１．６ｗｔ％を超えると耐水素遅れ割れ特性が劣化する。

【００１４】Ｃｒ：Ｍｎとの相互作用により鋼の焼入れ性を上げ、目標とする強度を確保するために必要な元素である。添加量が０．０５ｗｔ％未満であるとその効果が乏しい。添加量が０．６ｗｔ％を超えると耐水素遅れ割れ特性が劣化する。

【００１５】Ａｌ：脱酸元素として添加される。また、鋼中に固溶するＮをＡｌＮとして固定し、耐水素遅れ割れ特性を向上させる。０．０１ｗｔ％未満だとその効果は少ない。０．０６ｗｔ％を超えると介在物が増加し、耐水素遅れ割れ特性が劣化する。

【００１６】Ｐ：０．０２ｗｔ％を超えると耐水素遅れ割れ特性を劣化させる。

【００１７】Ｓ：介在物として存在し、耐水素遅れ割れ特性を劣化させるため、０．００３ｗｔ％以下であることが必要である。

【００１８】Ｎ：０．００５ｗｔ％を超えると、耐水素遅れ割れ特性が低下する。

【００１９】Ｔｉ：固溶Ｎを固定し、Ｂの焼入れ性を確保する効果があるので、添加する方が好ましいが、粗大な窒化物として析出すると耐水素遅れ割れ特性を低下させるので、０．０１５ｗｔ％以下である必要がある。

【００２０】Ｂ：マルテンサイトを生成させ、目標とする強度を確保するために必須な元素である。添加量が０．０００５ｗｔ％未満であると目標とする９８０Ｎ／ｍｍ²以上の強度が得られない。また、マルテンサイトを生成させるためには、オーステナイト中に固溶しているＢがフェライト変態を抑制する必要があるが、ＢはＮやＴｉと化合物を形成するので、オーステナイト中に固溶ＢをＢ＊としたとき、次の（１）式を満足させる必要がある。

【００２１】Ｂ＊≧０．０００５　（１）

ただし、Ｎ≧（１４／４８）Ｔｉのとき

Ｂ＊＝Ｂ－（１１／１４）Ｎ＋（１１／４８）Ｔｉ

Ｎ＜（１４／４８）Ｔｉのとき

Ｂ＊＝Ｂ

なお、Ｂの添加量が０．００３ｗｔ％を超えるとその効果が飽和する。

【００２２】高張力電縫鋼管の素材である熱延鋼板の熱延条件の限定理由を以下に説明する。

【００２３】仕上温度：（ＴＡｒ₃＋３０）℃未満だと、９８０Ｎ／ｍｍ² 以上の強度を得るためのマルテンサイトの体積率が得られない。（ＴＡｒ₃＋１００）℃を超えると、マルテンサイトパケットが粗大化し、耐水素遅れ割れ特性が低下する。

【００２４】圧下率：マルテンサイトを微細にし、耐水素遅れ割れ特性を良好にせしめるには、熱間圧延終了直前における強圧下が必要である。それにはＴｆ～（Ｔｆ＋３０）℃の温度範囲で３０％以上の圧下率を与えて熱間圧延する必要がある。

【００２５】熱間圧延後の冷却条件：９８０Ｎ／ｍｍ² 以上の強度を得るためのマルテンサイトの体積率を確保するために、熱間圧延後直ちに６０～２００℃／ｓの冷却速度で１５０～２５０℃の温度範囲にある温度Ｔｃまで急冷する必要がある。冷却速度が６０℃／ｓに満たないと所望の体積率のマルテンサイトが得られない。冷却速度が２００℃／ｓを超えると、操業上のトラブルを生じる。また、２５０℃以下まで急冷しないと所望の体積率のマルテンサイトが得られない。

【００２６】急冷後は硬質な焼戻しマルテンサイトを生成させるため、１５０℃以上前記温度Ｔｃ以下の温度範囲に、保持あるいは緩冷却などにより鋼板を２秒以上滞留させる必要がある。図１に、急冷された鋼板を１５０～２５０℃の温度範囲で保持したときの保持時間と水素遅れ割れ発生限界付加歪み$\Delta\varepsilon$との関係を示す。２秒以上の保持によって、２０００μｍ以上の高い水素遅れ割れ発生限界付加歪み$\Delta\varepsilon$が安定して得られることがわかる。２秒未満では、焼入れ歪みが残存するため、１９００μｍ以上の高い水素遅れ割れ発生限界付加歪み$\Delta\varepsilon$が安定して得られない。

【００２７】ここで、水素遅れ割れ発生限界付加歪み$\Delta\varepsilon$とは、電縫鋼管より幅２０ｍｍのＣ－リング試験片を切出し、切出し前の外径までボルト締めを行い、電縫鋼管の残留歪み相当の歪みを加えた後、さらに式（３）で計算される付加歪みを加えて０．１Ｎ塩酸中に２００時間浸漬し割れ発生有無を調べ、割れが発生する限界の付加歪みを求め、耐水素遅れ割れ特性の指標とした。この値が高いほど、耐水素遅れ割れの特性にとっては好ましい。

【００２８】

$$\Delta\varepsilon=(4\cdot10^{6}\cdot t\cdot\delta)/(\pi\cdot D\cdot(D-t))\quad(3)$$

式（３）で、ｔは板厚、Ｄは切出し前の外径、δはＤ－（付加歪み付加後の外径）

巻取温度：１５０℃を超えると、硬質な焼戻しマルテンサイト相とならず、９８０Ｎ／ｍｍ² 以上の強度が得られない。

【００２９】以上のような条件で製造された熱延鋼板を用い高張力電縫鋼管を製造するにあたり、その造管条件の限定理由を以下に説明する。

【００３０】図２に、前記式（２）から求めた偏絞り率Ｑを用いて算出したＱ／（ｔ／Ｄ）² と水素遅れ割れ発生限界付加歪み$\Delta\varepsilon$の関係を示す。Ｑ／（ｔ／Ｄ）² の値が１０００以上３０００以下のとき、２０００μｍ以上の高い水素遅れ割れ発生限界付加歪み$\Delta\varepsilon$が安定して得らる。Ｑ／（ｔ／Ｄ）² の値が１０００未満では、残留歪みが増大するため、また、３０００を超える場合は、造管時に強い変形集合組織が形成されるため水素割れ感受性が高まり、１９００μｍ以上の高い水素遅れ割れ発生限界付加歪み$\Delta\varepsilon$が得られない。

【００３１】請求項２に記載の第２の発明は、第１の発明の鋼成分に加え、ｗｔ％で、Ｎｂ：０．００５～０．０３、Ｖ：０．００５～０．０３のうち少なくとも１種以上を含有するように成分調整されたスラブを用い、熱間圧延以降の工程を第１の発明と同様な方法で行うことを特徴とする耐水素遅れ割れ特性に優れた高張力電縫鋼管の製造方法に関するものである。

【００３２】Ｎｂ、Ｖ量の限定理由を以下に説明する。Ｎｂ、Ｖは、いずれも変態前のオーステナイト粒を微細化し、変態後のマルテンサイトパケットを微細化できるので、耐水素遅れ割れ特性の向上には好ましい元素である。しかし０．００５ｗｔ％未満では、その効果は少なく、また０．０３ｗｔ％を超えて過度に添加すると、耐水素遅れ割れ特性がかえって劣化する。

【００３３】請求項３に記載の第３の発明は、第１の発明または第２の発明の鋼成分に加え、ｗｔ％で、Ｃｕ：０．０５～０．５を含有するように成分調整されたスラブを用い、熱間圧延以降の工程を第１の発明と同様な方法で行うことを特徴とする耐水素遅れ割れ特性に優れた高張力電縫鋼管の製造方法に関するものである。

【００３４】Ｃｕ量の限定理由を以下に説明する。Ｃｕは、鋼の腐食の進行を抑制するとともに鋼中への水素の侵入を抑制するので、耐水素遅れ割れ特性を向上させる。図３に，Ｃｕ添加量と水素割れ発生限界付加歪みΔεの変化量との関係を示す。Ｃｕを０．０５ｗｔ％以上添加することにより水素遅れ割れ発生限界付加歪みの変化量は増大し、水素遅れ割れの発生が抑制される。ま

＊た、０．５ｗｔ％超えて添加してもその効果は飽和するので、その上限は０．５ｗｔ％とする。

【００３５】なおＣｕ量を増加すると、場合によってはＣｕキズと呼ばれる表面欠陥が発生することがある。Ｎｉ添加によってＣｕきずの発生を防止できるが、Ｎｉは耐水素遅れ割れ特性にとって有害な元素であるため、その添加量は０．３ｗｔ％以内に制限されることが望ましい。

【００３６】

【実施例】

（実施例１）表１に示す本発明範囲内の成分系である鋼Ａ～ＥとＣ量およびＢ量が本発明範囲外の鋼Ｆの６種の鋼を溶製し、表２に示す本発明範囲内の熱延条件および造管条件にて３４．０φ×２．３ｍｍｔの電縫鋼管を作製した。そして、鋼管の引張強度および前記した耐水素遅れ割れ特性の指標である水素遅れ割れ発生限界付加歪みΔεを測定した。

【００３７】結果を表３に示す。本発明範囲内の成分系である鋼Ａ～Ｅは、いずれも９８０Ｎ／ｍｍ² 以上の強度を示し、かつ２０００μｍ以上の高い水素遅れ割れ発生限界付加歪みΔεが安定して得られる。また、組織的には、表２に示すように１００％焼戻マルテンサイトであった。一方、Ｃ量およびＢ量が本発明範囲外の鋼Ｆは、強度上の問題はないが、水素遅れ割れ発生限界付加歪みΔεが著しく低く、耐水素遅れ割れ特性が劣る。

【００３８】

【表１】

鋼	化学成分（wt%、BとB*の単位は ppm ）												備考
	C	Si	Mn	P	S	Al	Cr	N	Ti	B	B*	Others	
A	0.12	0.40	1.40	0.01	0.002	0.04	0.43	0.002	0.012	12	12	-	
B	0.15	0.41	1.51	0.01	0.002	0.03	0.41	0.002	0.000	22	5	0.22Cu	
C	0.15	0.41	1.55	0.01	0.002	0.03	0.47	0.002	0.009	8	8	0.010Nb	発明材
D	0.18	0.40	1.35	0.01	0.002	0.03	0.43	0.002	0.011	9	9	-	
E	0.18	0.39	1.30	0.01	0.002	0.03	0.44	0.002	0.008	11	11	0.27Cu	
F	0.23	0.40	1.82	0.01	0.002	0.03	0.02	0.003	0.000	0	0	-	比較材

【００３９】

※ ※【表２】

鋼	番号	Ar3 温度 (℃)	熱延条件					造管条件				組織	備考
			仕上温度 (℃)	30%圧下温度 (℃)	冷却速度 ℃/s	保持時間 (s)	巻取温度 (℃)	板厚 t (mm)	外径 D (mm)	幅絞り率 Q(%)	Q/(t/D)²	焼戻しマルテンサイト分率 (%)	
A	1	820	910	935	120	2.1	90	2.3	34.0	6.5	1420	100	
B	2	810	910	940	110	2.2	90	2.3	34.0	6.5	1420	100	
C	3	810	890	915	115	2.5	70	2.3	34.0	6.5	1420	100	発明例
D	4	800	900	920	110	2.6	60	2.3	34.0	6.5	1420	100	
E	5	800	870	890	110	2.5	70	2.3	34.0	6.5	1420	100	
F	6	790	890	910	120	2.1	50	2.3	34.0	6.5	1420	100	比較例

【００４０】

【表３】

鋼	番号	引張特性 TS (N/mm²)	耐水素遅れ割れ特性 割れ発生限界付加歪み、Δε(μm)	備考
A	1	1160	2140	
B	2	1350	2860	発明例
C	3	1370	2140	
D	4	1490	2140	
E	5	1490	2620	
F	6	1640	0	比較例

【００４１】（実施例２）表１の鋼Ａ～Ｅを用い、表４に示すような熱延条件および造管条件を種々変化させて電縫鋼管を作製した。そして、鋼管の引張強度および水素遅れ割れ発生限界付加歪みΔεを測定した。

＊【００４２】結果を表５に示す。熱延条件、造管条件が本発明範囲内にある電縫鋼管は、引張強度が９８０Ｎ／ｍｍ² で、かつ２０００μｍ以上の高い水素遅れ割れ発生限界付加歪みΔεが安定して得られる。また、組織的には、表４に示すように８０％以上の焼戻マルテンサイトとフェライトからなる複合組織であった。一方、熱延条件、造管条件が本発明範囲外の試料では、引張強度が不足したり、水素遅れ割れ発生限界付加歪みΔεが９５０μｍとそれほど高くなく、かつ安定してΔεの値が得られなかった。

【００４３】

【表４】

鋼	番号	Ar3温度(℃)	熱延条件 仕上温度(℃)	30%圧下温度(℃)	冷却速度℃/s	保持時間(s)	巻取温度(℃)	造管条件 板厚t(mm)	外径D(mm)	幅絞り率Q(%)	Q/(t/D)²	組織 焼戻しﾏﾙﾃﾝｻｲﾄ分率(%)	備考
A	7	820	840	865	80	2.1	90	2.3	38.1	3.9	1070	85	発明例
	8		900	930	110	2.4	60	2.3	31.8	8.2	1568	100	
	9		890	915	50	2.4	70	2.3	38.1	3.9	1070	60	比較例
	10		910	930	110	2.2	80	2.3	31.8	4.8	918	100	
B	11	810	850	880	100	2.5	80	3.2	31.8	11.8	1165	100	
	12		870	885	115	2.3	80	2.3	34.0	10.5	2295	100	発明例
	13		880	900	100	2.4	70	3.2	38.1	7.5	1063	100	
	14		820	840	100	2.1	90	2.3	38.1	3.9	1070	70	比較例
	15		930	950	120	2.0	90	2.3	31.8	8.2	1568	100	
C	16	810	850	875	110	2.6	80	2.3	38.1	3.9	1070	100	発明例
	17		860	880	105	3.0	90	3.2	31.8	11.8	1165	100	
	18		870	990	105	2.9	60	2.3	38.1	11.8	3238	100	比較例
	19		870	885	100	>2.0	180	3.2	31.8	11.8	1165	*1	
D	20	800	860	890	110	2.8	80	2.3	38.1	3.9	1070	100	
	21		900	920	110	2.8	80	2.0	34.0	9.5	2746	100	発明例
	22		870	890	115	2.8	70	2.0	34.0	6.5	1879	100	
	23		880	900	110	2.3	80	2.3	31.8	8.2	1568	100	
	24		890	915	90	1.3	60	2.3	38.1	3.9	1070	*2	
	25		900	950	100	2.3	70	2.0	34.0	6.5	1879	100	比較例
	26		900	920	90	2.2	70	2.0	38.1	9.6	3484	100	
E	27	800	900	925	120	2.2	60	2.3	34.0	6.5	1420	100	発明例
	28		850	880	105	2.1	80	2.0	31.8	7.2	1820	100	
	29		860	880	105	1.3	80	2.0	34.0	6.5	1879	*2	比較例
	30		840	865	90	2.2	100	2.3	31.8	3.9	746	100	

*1：ﾍﾞｲﾅｲﾄ100%　*2:焼入れままﾏﾙﾃﾝｻｲﾄ100%

【００４４】

【表５】

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鋼	番号	引張特性 TS (N/mm²)	耐水素遅れ割れ特性 割れ発生限界付加歪み Δε(μm)	備考
A	7	1030	2140	発明例
	8	1190	2140	
	9	830	2140	比較例
	10	1150	950	
B	11	1360	2860	発明例
	12	1390	2860	
	13	1340	2860	
	14	880	2860	比較例
	15	1360	950	
C	16	1310	2140	発明例
	17	1350	2140	
	18	1380	950	比較例
	19	950	2140	
D	20	1490	2140	発明例
	21	1480	2140	
	22	1500	2140	
	23	1500	2140	
	24	1490	950	比較例
	25	1510	950	
	26	1550	950	
E	27	1480	2620	発明例
	28	1510	2620	
	29	1530	950	比較例
	30	1490	950	

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＊【図面の簡単な説明】

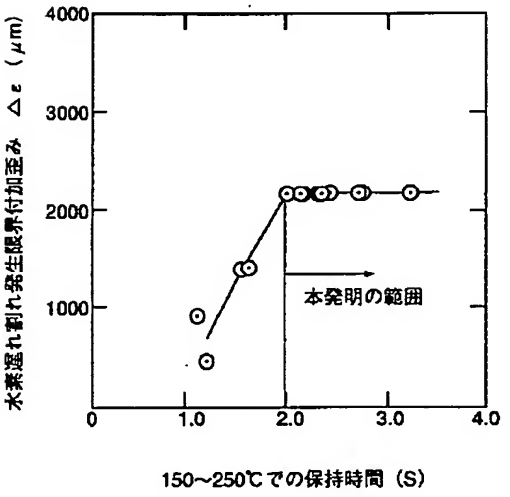
【図１】１５０～２５０℃の温度範囲における保持時間と水素遅れ割れ発生限界付加歪みΔεとの関係を示す図である。

【図２】Q／（t／D）² と水素遅れ割れ発生限界付加歪みΔεの関係を示す図である。

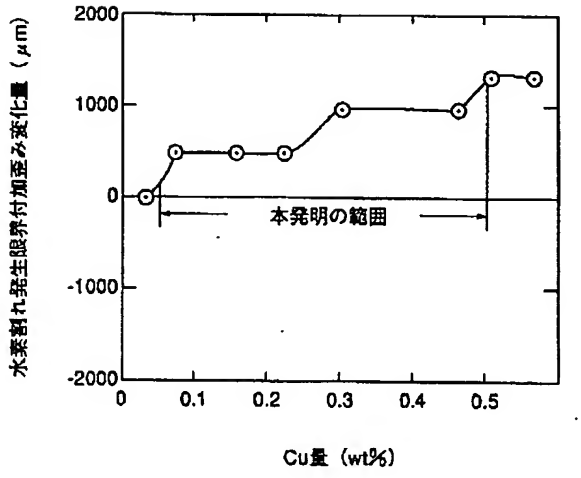
【図３】Ｃｕ添加量と割れ発生限界付加歪みΔεの変化量との関係を示す図である。

＊

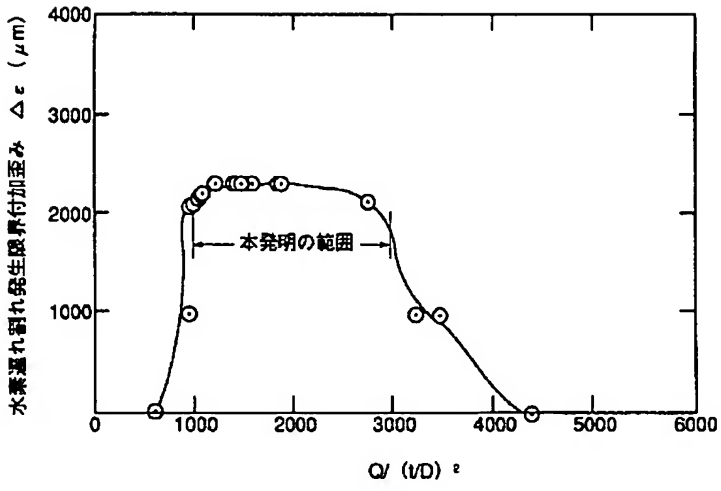
【図１】



【図３】



【図２】



フロントページの続き

(51)Int.Cl.⁷	識別記号	Ｆ Ｉ
Ｃ２２Ｃ　38/22		Ｃ２２Ｃ　38/22

(56)参考文献　特開　昭59－48846（ＪＰ，Ａ）
特開　平１－205032（ＪＰ，Ａ）
特開　平４－187319（ＪＰ，Ａ）
特開　平６－88129（ＪＰ，Ａ）

(58)調査した分野(Int.Cl.⁷，ＤＢ名)
B21C　37/08
C21D　38/00 - 38/60

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CLAIMS

---

(57) [Claim(s)]
[Claim 1] At wt%, C:0.1 to 0.19, Si:0.01-0.5, Mn:0.8-1.6, Cr:0.05-0.6, aluminum:0.01-0.06, and P:0.02 (0 is included) or less It has the presentation which are S:0.003 (0 is included) or less, N:0.005 (0 is included) or less, less than [Ti:0.015] (0 is included), and B:0.0005-0.003, and adjusted the amount of B so that a formula (1) might be satisfied, and is B* >=0.0005. (1) However, are in charge of hot-rolling the slab of the steel with which the B* =B remainder consists of Fe and an unescapable impurity substantially at the time of B* =B-(11/14) N+ (11/48) TiN<(14/48) Ti at the time of N>=(14/48) Ti. Ar3 of said steel It is the temperature of the transformation point TAr3 When it carries out, finishing temperature Tf is controlled and hot-rolled so that finishing temperature Tf may become the temperature requirement of -(TAr 3+30) (TAr 3+100) **. And 30% or more of rolling reduction is then given and hot-rolled in the temperature requirement of Tf - (Tf+30) **. To the temperature Tc which is in a 150-250-degree C temperature requirement with the cooling rate of 60-200 degrees C/s promptly after hot rolling, after cooling, The manufacture approach of a high tension electroseamed steel pipe excellent in the hydrogen-proof delay crack property characterized by forming a tube by width-of-face contraction percentage Q which is made to pile up in the temperature requirement below said Tc 2 seconds or more 150 degrees C or more, rolls round at the temperature of less than 150 degrees C, produces hot rolled sheet steel, and fills a formula (2) using said hot rolled sheet steel.
1000 <=Q/(t/D)2 <=3000 (2)
Here, the board thickness of hot rolled sheet steel and D (mm) of t (mm) are width-of-face contraction percentages, and the outer diameter of an electroseamed steel pipe and Q (%) are defined by the formula (3).
Q=[(width of face of steel plate - pi (D-t)) /pi(D-t)] x100 (3)
[Claim 2] The manufacture approach of a high tension electroseamed steel pipe that steel slab was excellent in the hydrogen-proof delay crack property according to claim 1 characterized by containing at least one or more of Nb:0.005-0.03 and V:0.005-0.03 sorts at wt%.
[Claim 3] The manufacture approach of a high tension electroseamed steel pipe that steel slab was excellent in the hydrogen-proof delay crack property according to claim 1 or 2 characterized by containing Cu:0.05-0.5 at wt%.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the manufacture approach of the high tension electroseamed steel pipe used for the door impact beam of an automobile etc.
[0002]
[Description of the Prior Art] The reinforcing materials called a door impact beam from a viewpoint of safety are prepared in the interior of car Doat, such as an automobile. Although the press-forming article of cold rolled high tensile strength steel sheets was used for the conventional door impact beam in many cases, tensile strength is 2 980Ns/mm because of recent years and lightweight-izing. The above remarkable high tension electroseamed steel pipe with high reinforcement has come to be adopted.
[0003] However, reinforcement is remarkably high, and when using for a door impact beam the high tension electroseamed steel pipe with which residual distortion is moreover added by tubulation, and corrosion advances inside Doat, there is a possibility that the so-called "hydrogen delay crack" by which hydrogen invades into steel and steel is destroyed may arise.
[0004] Until now, about the high tension electroseamed steel pipe using hot rolled sheet steel and cold rolled sheet steel with reinforcement it is remarkable and high, or its manufacture approach, it is introduced by JP,1-205032,A, JP,4-131327,A, JP,4-187319,A, JP,6-88129,A, etc.
[0005]
[Problem(s) to be Solved by the Invention] However, consideration of as opposed to a "hydrogen delay crack" in all is not made.
[0006] For this invention, it is made in order to solve such a technical problem, and tensile strength is 2 980Ns/mm. It is above and aims at offering the manufacture approach of a high tension electroseamed steel pipe of moreover having excelled in the hydrogen-proof delay crack property.
[0007]
[Means for Solving the Problem] this invention person etc. found out the knowledge that the above-mentioned technical problem was solved, by fitness-izing a steel component, hot-rolling conditions, and tubulation conditions, as a result of considering wholeheartedly the manufacture approach of a high tension electroseamed steel pipe excellent in the hydrogen-proof delay crack property.
[0008] The 1st invention according to claim 1 is wt%. C:0.1 to 0.19, Si:0.01-0.5, Mn:0.8-1.6, Cr:0.05-0.6, aluminum:0.01-0.06, and P:0.02 (0 is included) or less [namely,] It has the presentation which are S:0.003 (0 is included) or less, N:0.005 (0 is included) or less, less than [Ti:0.015] (0 is included), and B:0.0005-0.003, and adjusted the amount of B so that a formula (1) might be satisfied, and is B* >=0.0005. (1)
However, are in charge of hot-rolling the slab of the steel with which the B* =B remainder consists of Fe and an unescapable impurity substantially at the time of B* =B-(11/14) N+ (11/48) Ti<(14/48) Ti at the time of N>=(14/48) Ti. Ar3 of said steel It is the temperature of the transformation point TAr3 When it carries out, finishing temperature Tf is controlled and hot-rolled so that finishing temperature Tf may become the temperature requirement of -(TAr 3+30)

(TAr 3+100) **. And 30% or more of rolling reduction is then given and hot-rolled in the temperature requirement of Tf - (Tf+30) **. To the temperature Tc which is in a 150-250-degree C temperature requirement with the cooling rate of 60-200 degrees C/s promptly after hot rolling, after cooling, Make 150 degrees C or more pile up in the temperature requirement below said Tc 2 seconds or more, roll round at the temperature of less than 150 degrees C, and hot rolled sheet steel is produced. It is related with the manufacture approach of a high tension electroseamed steel pipe excellent in the hydrogen-proof delay crack property characterized by forming a tube by width-of-face contraction percentage Q which fills a formula (2) using said hot rolled sheet steel.

[0009]

1000 <=Q/(t/D)2 <=3000 (2)

Here, the board thickness of hot rolled sheet steel and D (mm) of t (mm) are width-of-face contraction percentages, and the outer diameter of an electroseamed steel pipe and Q (%) are defined by the formula (3).

[0010]

Q=[(width of face of steel plate - pi (D-t)) /pi(D-t)] x100 (3)

The reason for component definition of steel is explained below.

[0011] C: Since it is a martensite generation element and is the element which raises the hardness of martensite, it is an indispensable element in order to secure target reinforcement. 980N/mm2 made into a target for an addition to be less than [0.1wt%] The above reinforcement is not obtained. If an addition exceeds 0.19wt(s)%, a hydrogen-proof delay crack property will deteriorate.

[0012] Si: It is necessary to add in order to secure the soundness of the electric-resistance-welding section, and the soundness of the electric-resistance-welding section becomes good in the range whose addition is 0.01 - 0.5wt%.

[0013] Mn: It is an indispensable element, in order to make raising and martensite generate the hardenability of an austenite and to secure target reinforcement. 980N/mm2 made into a target for an addition to be less than [0.8wt%] The above reinforcement is not obtained. If an addition exceeds 1.6wt(s)%, a hydrogen-proof delay crack property will deteriorate.

[0014] It is an element required in order to secure raising and target reinforcement by the interaction with Cr:Mn. [hardenability / of steel] The effectiveness is scarce in an addition being less than [0.05wt%]. If an addition exceeds 0.6wt(s)%, a hydrogen-proof delay crack property will deteriorate.

[0015] aluminum: It is added as a deoxidation element. Moreover, N which dissolves in steel is fixed as AlN, and a hydrogen-proof delay crack property is raised. 0. When it is less than [01wt%], there is little the effectiveness. 0. If 06wt% is exceeded, inclusion will increase and a hydrogen-proof delay crack property will deteriorate.

[0016] P: If 0.02wt% is exceeded, a hydrogen-proof delay crack property will be degraded.

[0017] S: In order to exist as inclusion and to degrade a hydrogen-proof delay crack property, it is required to be less than [0.003wt%].

[0018] N: If 0.005wt% is exceeded, a hydrogen-proof delay crack property will fall.

[0019] Ti: Although it is more desirable to add since it is effective in fixing Dissolution N and securing the hardenability of B, since a hydrogen-proof delay crack property will be reduced if deposited as a big and rough nitride, it is necessary to be less than [0.015wt%].

[0020] B: It is an indispensable element, in order to make martensite generate and to secure target reinforcement. The reinforcement of two or more [980Ns //mm] made into a target for an addition to be less than [0.0005wt%] is not obtained. Moreover, although B which is dissolving in an austenite needs to control a ferrite transformation in order to make martensite generate, since B forms N, Ti, and a compound, it is Dissolution B in an austenite When it carries out, it is necessary to satisfy the following (1) type. B*

[0021] B* >=0.0005 (1)

however, the time of N>=(14/48) Ti -- the time of B* =B-(11/14) N+(11/48) TiN<(14/48) Ti -- B* =B -- in addition, if the addition of B exceeds 0.003wt(s)%, the effectiveness will be saturated.

[0022] The reason for definition of the hot-rolling conditions of the hot rolled sheet steel which is the raw material of a high tension electroseamed steel pipe is explained below.
[0023] Finishing temperature: (TAr 3+30) When it is under **, it is 2 980Ns/mm. The rate of the volume of the martensite for obtaining the above reinforcement is not obtained. (TAr 3+100) If ** is exceeded, a martensite packet will make it big and rough, and a hydrogen-proof delay crack property will fall.
[0024] Rolling reduction: In order to make martensite detailed and to cheat out of a hydrogen-proof delay crack property good, the bottom of the pressure in front of hot rolling termination is required. It is necessary to give and hot-roll 30% or more of rolling reduction to it in the temperature requirement of Tf - (Tf+30) **.
[0025] The cooling conditions after hot rolling: 980N/mm2 In order to secure the rate of the volume of the martensite for obtaining the above reinforcement, it is necessary to quench to the temperature Tc which is in a 150-250-degree C temperature requirement with the cooling rate of 60-200 degrees C/s promptly after hot rolling. Unless it fills [s] a cooling rate in 60 degrees C /, the martensite of the desired rate of the volume is not obtained. If a cooling rate exceeds s in 200 degrees C /, the trouble on operation will be produced. Moreover, unless it quenches to 250 degrees C or less, the martensite of the desired rate of the volume is not obtained.
[0026] After quenching needs to make 150 degrees C or more of steel plates pile up in the temperature requirement below said temperature Tc 2 seconds or more by maintenance or garadual cooling in order to make hard tempered martensite generate. The relation between the holding time when holding the steel plate which drawing 1 quenched in a 150-250-degree C temperature requirement, and hydrogen delay crack generating marginal addition distortion deltaepsilon is shown. It turns out that 2000 micrometers or more high hydrogen delay crack generating marginal addition distortion deltaepsilon is stabilized, and is obtained by the maintenance for 2 seconds or more. In less than 2 seconds, since hardening distortion remains, 1900 micrometers or more high hydrogen delay crack generating marginal addition distortion deltaepsilon is stabilized, and is not obtained.
[0027] Here with hydrogen delay crack generating marginal addition distortion deltaepsilon From an electroseamed steel pipe, cut down C-ring test piece with a width of face of 20mm, and bolting is performed to the outer diameter before logging. After adding distortion of the residual distortion of an electroseamed steel pipe, addition distortion further calculated by the formula (3) was added, it was immersed into 0.1-N hydrochloric acid for 200 hours, crack generating existence was investigated, and it asked for the addition distortion of the limitation which a crack generates, and considered as the index of a hydrogen-proof delay crack property. For the property of a hydrogen-proof delay crack, it is so desirable that this value is high.
[0028]
deltaepsilon=(4, 106, and t-delta)/(pi-D- (D-t)) (3)
For board thickness and D, at a formula (3), the outer diameter before logging and delta are [t] D. - (outer diameter after addition distortion addition)
Winding temperature: When it exceeds 150 degrees C, it does not become a hard tempering martensitic phase, but is 2 980Ns/mm. The above reinforcement is not obtained.
[0029] In manufacturing a high tension electroseamed steel pipe using the hot rolled sheet steel manufactured on the above conditions, the reason for definition of the tubulation condition is explained below.
[0030] Q/(t/D) 2 computed using width-of-face contraction percentage Q for which drawing 2 was asked from said formula (2) The relation of hydrogen delay crack generating marginal addition distortion deltaepsilon is shown. Q/2 (t/D) When a value is 3000 or less [1000 or more], 2000 micrometers or more high hydrogen delay crack generating marginal addition distortion deltaepsilon is stabilized, and it is ******. Q/2 (t/D) Since the deformation texture where it is strong at the time of tubulation when a value exceeds 3000 since residual distortion increases less than by 1000 and is formed, hydrogen crack sensitivity increases, and 1900 micrometers or more high hydrogen delay crack generating marginal addition distortion deltaepsilon is not obtained.
[0031] In addition to the steel component of the 1st invention, the 2nd invention according to

claim 2 is wt%, and relates to the manufacture approach of a high tension electroseamed steel pipe excellent in the hydrogen-proof delay crack property characterized by performing the process after hot rolling by the same approach as the 1st invention using the slab by which the quality governing was carried out so that at least one or more of Nb:0.005-0.03 and V:0.005-0.03 sorts might be contained.

[0032] The reason for definition of Nb and the amount of V is explained below. Since each of Nb (s) and V makes the austenite grain before a transformation detailed and can carry out [detailed]-izing of the martensite packet after a transformation, it is an element desirable to improvement in a hydrogen-proof delay crack property. However, less than [0.005wt%], if there is little the effectiveness and it adds too much exceeding 0.03wt(s)%, a hydrogen-proof delay crack property will deteriorate on the contrary.

[0033] In addition to the steel component of the 1st invention or the 2nd invention, the 3rd invention according to claim 3 is wt%, and relates to the manufacture approach of a high tension electroseamed steel pipe excellent in the hydrogen-proof delay crack property characterized by performing the process after hot rolling by the same approach as the 1st invention using the slab by which the quality governing was carried out so that Cu:0.05-0.5 might be contained.

[0034] The reason for definition of the amount of Cu(s) is explained below. Since Cu controls trespass of the hydrogen to the inside of steel while controlling progress of the corrosion of steel, it raises a hydrogen-proof delay crack property. The relation between Cu addition and the variation of hydrogen crack generating marginal addition distortion deltaepsilon is shown in drawing 3 . Cu -- more than 0.05wt% -- by adding, the variation of hydrogen delay crack generating marginal addition distortion increases, and generating of a hydrogen delay crack is controlled. moreover, 0.5wt% -- since the effectiveness is saturated even if it exceeds and adds, the upper limit is made into 0.5wt(s)%.

[0035] In addition, an increment of the amount of Cu(s) may generate the surface discontinuity called Cu crack depending on the case. Although generating of Cu flaw can be prevented by nickel addition, since nickel is an element harmful for a hydrogen-proof delay crack property, as for the addition, being restricted to less than [0.3wt%] is desirable.

[0036]

[Example]

(Example 1) Steel A-E, the amount of C, and the amount of B which are the component system of this invention within the limits shown in a table 1 ingoted six sorts of steel of the steel F outside this invention range, and produced the electroseamed steel pipe of 34.0phix2.3mmt on the hot-rolling conditions and tubulation conditions of this invention within the limits shown in a table 2. And hydrogen delay crack generating marginal addition distortion deltaepsilon which is the tensile strength of a steel pipe and the above mentioned index of a hydrogen-proof delay crack property was measured.

[0037] A result is shown in a table 3. Each steel A-E which is the component system of this invention within the limits is 2 980Ns/mm. The above reinforcement is shown, and 2000 micrometers or more high hydrogen delay crack generating marginal addition distortion deltaepsilon is stabilized, and is obtained. Moreover, systematically, as shown in a table 2, it was 100% tempered martensite. On the other hand, although the steel F outside this invention range does not have a problem on reinforcement as for the amount of C, and the amount of B, hydrogen delay crack generating marginal addition distortion deltaepsilon is remarkably low, and a hydrogen-proof delay crack property is inferior.

[0038]

[A table 1]

鋼	化学成分(wt%、BとB*の単位は ppm)												備考
	C	Si	Mn	P	S	Al	Cr	N	Ti	B	B*	Others	
A	0.12	0.40	1.40	0.01	0.002	0.04	0.48	0.002	0.012	12	12	-	発明材
B	0.15	0.41	1.51	0.01	0.002	0.03	0.41	0.002	0.000	22	5	0.22Cu	
C	0.15	0.41	1.55	0.01	0.002	0.03	0.47	0.002	0.009	8	8	0.010Nb	
D	0.18	0.40	1.35	0.01	0.002	0.03	0.48	0.002	0.011	9	9	-	
E	0.18	0.39	1.30	0.01	0.002	0.03	0.44	0.002	0.008	11	11	0.27Cu	
F	0.23	0.40	1.82	0.01	0.002	0.03	0.02	0.003	0.000	0	0	-	比較材

[0039]
[A table 2]

鋼	番号	Ar3 温度 (℃)	熱延条件					造管条件				組織	備考
			仕上温度 (℃)	30%圧下温度 (℃)	冷却速度 ℃/s	保持時間 (s)	巻取温度 (℃)	板厚 t (mm)	外径 D (mm)	幅絞り率 Q(%)	Q/(t/D)²	焼戻しマルテンサイト分率 (%)	
A	1	820	910	935	120	2.1	90	2.3	34.0	6.5	1420	100	発明例
B	2	810	910	940	110	2.2	90	2.3	34.0	6.5	1420	100	
C	3	810	890	915	115	2.5	70	2.3	34.0	6.5	1420	100	
D	4	800	900	920	110	2.6	60	2.3	34.0	6.5	1420	100	
E	5	800	870	890	110	2.5	70	2.3	34.0	6.5	1420	100	
F	6	790	890	910	120	2.1	50	2.3	34.0	6.5	1420	100	比較例

[0040]
[A table 3]

鋼	番号	引張特性	耐水素遅れ割れ特性	備考
		TS (N/mm²)	割れ発生限界付加歪み.Δε(μm)	
A	1	1160	2140	発明例
B	2	1350	2860	
C	3	1370	2140	
D	4	1490	2140	
E	5	1490	2620	
F	6	1640	0	比較例

[0041] (Example 2) Various hot-rolling conditions as shown in a table 4, and tubulation conditions were changed using steel A-E of a table 1, and the electroseamed steel pipe was produced. And the tensile strength of a steel pipe and hydrogen delay crack generating marginal addition distortion deltaepsilon were measured.
[0042] A result is shown in a table 5. For the electroseamed steel pipe which has hot-rolling conditions and tubulation conditions in this invention within the limits, tensile strength is 2 980Ns/mm. And 2000 micrometers or more high hydrogen delay crack generating marginal addition distortion deltaepsilon is stabilized, and is obtained. Moreover, he was the complex tissue which consists of 80% or more of a tempered martensite and a ferrite systematically as shown in a table 4. On the other hand, hot-rolling conditions and tubulation conditions were not insufficient for tensile strength by the sample outside this invention range, and hydrogen delay crack generating marginal addition distortion deltaepsilon was not so so high as 950 micrometers, and it was stabilized and the value of deltaepsilon was not acquired.
[0043]
[A table 4]

鋼	番号	Ar3温度(℃)	熱延条件					造管条件				組織	備考
			仕上温度(℃)	30%圧下温度(℃)	冷却速度℃/s	保持時間(s)	巻取温度(℃)	板厚 t (mm)	外径 D (mm)	幅絞り率 Q(%)	Q/(t/D)²	焼戻しマルテンサイト分率(%)	
A	7	820	840	865	80	2.1	90	2.3	38.1	3.9	1070	85	発明例
	8		900	930	110	2.4	60	2.3	31.8	8.2	1568	100	
	9		890	915	50	2.4	70	2.3	38.1	3.9	1070	60	比較例
	10		910	930	110	2.2	80	2.3	31.8	4.8	918	100	
B	11	810	850	880	100	2.5	80	3.2	31.8	11.8	1165	100	
	12		870	885	115	2.3	80	2.3	34.0	10.5	2295	100	発明例
	13		880	900	100	2.4	70	3.2	38.1	7.5	1063	100	
	14		820	840	100	2.1	90	2.3	38.1	3.9	1070	70	比較例
	15		930	950	120	2.0	90	2.3	31.8	8.2	1568	100	
C	16	810	850	875	110	2.6	80	2.3	38.1	3.9	1070	100	発明例
	17		860	880	105	3.0	90	3.2	31.8	11.8	1165	100	
	18		870	990	105	2.9	60	2.3	38.1	11.8	3238	100	比較例
	19		870	885	100	>2.0	180	3.2	31.8	11.8	1165	*1	
D	20	800	860	890	110	2.8	80	2.3	38.1	3.9	1070	100	
	21		900	920	110	2.8	80	2.0	34.0	9.5	2746	100	発明例
	22		870	890	115	2.8	70	2.0	34.0	6.5	1879	100	
	23		880	900	110	2.3	80	2.3	31.8	8.2	1568	100	
	24		890	915	90	1.3	60	2.3	38.1	3.9	1070	*2	
	25		900	950	100	2.3	70	2.0	34.0	6.5	1879	100	比較例
	26		900	920	90	2.2	70	2.0	38.1	9.6	3484	100	
E	27	800	900	925	120	2.2	60	2.3	34.0	6.5	1420	100	発明例
	28		850	880	105	2.1	80	2.0	31.8	7.2	1820	100	
	29		860	880	105	1.3	80	2.0	34.0	6.5	1879	*2	比較例
	30		840	865	90	2.2	100	2.3	31.8	3.9	746	100	

*1：ベイナイト100%　*2:焼入れままマルテンサイト100%

[0044]

[A table 5]

鋼	番号	引張特性 TS (N/mm²)	耐水素遅れ割れ特性 割れ発生限界付加歪み Δε(μm)	備考
A	7	1030	2140	発明例
	8	1190	2140	
	9	830	2140	比較例
	10	1150	950	
B	11	1360	2860	
	12	1390	2860	発明例
	13	1340	2860	
	14	880	2860	比較例
	15	1360	950	
C	16	1310	2140	発明例
	17	1350	2140	
	18	1380	950	比較例
	19	950	2140	
D	20	1490	2140	
	21	1480	2140	発明例
	22	1500	2140	
	23	1500	2140	
	24	1490	950	
	25	1510	950	比較例
	26	1550	950	
E	27	1480	2620	発明例
	28	1510	2620	
	29	1530	950	比較例
	30	1490	950	

* NOTICES *

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TECHNICAL FIELD

[Field of the Invention] This invention relates to the manufacture approach of the high tension electroseamed steel pipe used for the door impact beam of an automobile etc.

[Translation done.]

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PRIOR ART

[Description of the Prior Art] The reinforcing materials called a door impact beam from a viewpoint of safety are prepared in the interior of car Doat, such as an automobile. Although the press-forming article of cold rolled high tensile strength steel sheets was used for the conventional door impact beam in many cases, tensile strength is 2 980Ns/mm because of recent years and lightweight-izing. The above remarkable high tension electroseamed steel pipe with high reinforcement has come to be adopted.
[0003] However, reinforcement is remarkably high, and when using for a door impact beam the high tension electroseamed steel pipe with which residual distortion is moreover added by tubulation, and corrosion advances inside Doat, there is a possibility that the so-called "hydrogen delay crack" by which hydrogen invades into steel and steel is destroyed may arise.
[0004] Until now, about the high tension electroseamed steel pipe using hot rolled sheet steel and cold rolled sheet steel with reinforcement it is remarkable and high, or its manufacture approach, it is introduced by JP,1-205032,A, JP,4-131327,A, JP,4-187319,A, JP,6-88129,A, etc.

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, consideration of as opposed to a "hydrogen delay crack" in all is not made.
[0006] For this invention, it is made in order to solve such a technical problem, and tensile strength is 2 980Ns/mm. It is above and aims at offering the manufacture approach of a high tension electroseamed steel pipe of moreover having excelled in the hydrogen-proof delay crack property.

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MEANS

[Means for Solving the Problem] this invention person etc. found out the knowledge that the above-mentioned technical problem was solved, by fitness-izing a steel component, hot-rolling conditions, and tubulation conditions, as a result of considering wholeheartedly the manufacture approach of a high tension electroseamed steel pipe excellent in the hydrogen-proof delay crack property.
[0008] The 1st invention according to claim 1 is wt%. C:0.1 to 0.19, Si:0.01-0.5, Mn:0.8-1.6, Cr:0.05-0.6, aluminum:0.01-0.06, and P:0.02 (0 is included) or less [namely,] It has the presentation which are S:0.003 (0 is included) or less, N:0.005 (0 is included) or less, less than [Ti:0.015] (0 is included), and B:0.0005-0.003, and adjusted the amount of B so that a formula (1) might be satisfied, and is B* >=0.0005. (1)
However, are in charge of hot-rolling the slab of the steel with which the B* =B remainder consists of Fe and an unescapable impurity substantially at the time of B* =B-(11/14) N+ (11/48) TiN<(14/48) Ti at the time of N>=(14/48) Ti. Ar3 of said steel It is the temperature of the transformation point TAr3 When it carries out, finishing temperature Tf is controlled and hot-rolled so that finishing temperature Tf may become the temperature requirement of -(TAr 3+30) (TAr 3+100) **. And 30% or more of rolling reduction is then given and hot-rolled in the temperature requirement of Tf - (Tf+30) **. To the temperature Tc which is in a 150-250-degree C temperature requirement with the cooling rate of 60-200 degrees C/s promptly after hot rolling, after cooling, Make 150 degrees C or more pile up in the temperature requirement below said Tc 2 seconds or more, roll round at the temperature of less than 150 degrees C, and hot rolled sheet steel is produced. It is related with the manufacture approach of a high tension electroseamed steel pipe excellent in the hydrogen-proof delay crack property characterized by forming a tube by width-of-face contraction percentage Q which fills a formula (2) using said hot rolled sheet steel.
[0009]
1000 <=Q/(t/D)2 <=3000 (2)
Here, the board thickness of hot rolled sheet steel and D (mm) of t (mm) are width-of-face contraction percentages, and the outer diameter of an electroseamed steel pipe and Q (%) are defined by the formula (3).
[0010]
Q=[(width of face of steel plate - pi (D-t)) /pi(D-t)] x100 (3)
The reason for component definition of steel is explained below.
[0011] C: Since it is a martensite generation element and is the element which raises the hardness of martensite, it is an indispensable element in order to secure target reinforcement. 980N/mm2 made into a target for an addition to be less than [0.1wt%] The above reinforcement is not obtained. If an addition exceeds 0.19wt(s)%, a hydrogen-proof delay crack property will deteriorate.
[0012] Si: It is necessary to add in order to secure the soundness of the electric-resistance-welding section, and the soundness of the electric-resistance-welding section becomes good in the range whose addition is 0.01 - 0.5wt%.
[0013] Mn: It is an indispensable element, in order to make raising and martensite generate the

hardenability of an austenite and to secure target reinforcement. 980N/mm2 made into a target for an addition to be less than [0.8wt%] The above reinforcement is not obtained. If an addition exceeds 1.6wt(s)%, a hydrogen-proof delay crack property will deteriorate.
[0014] It is an element required in order to secure raising and target reinforcement by the interaction with Cr:Mn. [hardenability / of steel] The effectiveness is scarce in an addition being less than [0.05wt%]. If an addition exceeds 0.6wt(s)%, a hydrogen-proof delay crack property will deteriorate.
[0015] aluminum: It is added as a deoxidation element. Moreover, N which dissolves in steel is fixed as AlN, and a hydrogen-proof delay crack property is raised. 0. When it is less than [01wt%], there is little the effectiveness. 0. If 06wt% is exceeded, inclusion will increase and a hydrogen-proof delay crack property will deteriorate.
[0016] P: If 0.02wt% is exceeded, a hydrogen-proof delay crack property will be degraded.
[0017] S: In order to exist as inclusion and to degrade a hydrogen-proof delay crack property, it is required to be less than [0.003wt%].
[0018] N: If 0.005wt% is exceeded, a hydrogen-proof delay crack property will fall.
[0019] Ti: Although it is more desirable to add since it is effective in fixing Dissolution N and securing the hardenability of B, since a hydrogen-proof delay crack property will be reduced if deposited as a big and rough nitride, it is necessary to be less than [0.015wt%].
[0020] B: It is an indispensable element, in order to make martensite generate and to secure target reinforcement. The reinforcement of two or more [980Ns //mm] made into a target for an addition to be less than [0.0005wt%] is not obtained. Moreover, although B which is dissolving in an austenite needs to control a ferrite transformation in order to make martensite generate, since B forms N, Ti, and a compound, it is Dissolution B in an austenite When it carries out, it is necessary to satisfy the following (1) type. B*
[0021] B* >=0.0005 (1)
however, the time of N>=(14/48) Ti -- the time of B* =B-(11/14) N+(11/48) TiN<(14/48) Ti -- B* =B -- in addition, if the addition of B exceeds 0.003wt(s)%, the effectiveness will be saturated.
[0022] The reason for definition of the hot-rolling conditions of the hot rolled sheet steel which is the raw material of a high tension electroseamed steel pipe is explained below.
[0023] Finishing temperature: (TAr 3+30) When it is under **, it is 2 980Ns/mm. The rate of the volume of the martensite for obtaining the above reinforcement is not obtained. (TAr 3+100) If ** is exceeded, a martensite packet will make it big and rough, and a hydrogen-proof delay crack property will fall.
[0024] Rolling reduction: In order to make martensite detailed and to cheat out of a hydrogen-proof delay crack property good, the bottom of the pressure in front of hot rolling termination is required. It is necessary to give and hot-roll 30% or more of rolling reduction to it in the temperature requirement of Tf - (Tf+30) **.
[0025] The cooling conditions after hot rolling: 980N/mm2 In order to secure the rate of the volume of the martensite for obtaining the above reinforcement, it is necessary to quench to the temperature Tc which is in a 150-250-degree C temperature requirement with the cooling rate of 60-200 degrees C/s promptly after hot rolling. Unless it fills [s] a cooling rate in 60 degrees C /, the martensite of the desired rate of the volume is not obtained. If a cooling rate exceeds s in 200 degrees C /, the trouble on operation will be produced. Moreover, unless it quenches to 250 degrees C or less, the martensite of the desired rate of the volume is not obtained.
[0026] After quenching needs to make 150 degrees C or more of steel plates pile up in the temperature requirement below said temperature Tc 2 seconds or more by maintenance or garadual cooling in order to make hard tempered martensite generate. The relation between the holding time when holding the steel plate which drawing 1 quenched in a 150-250-degree C temperature requirement, and hydrogen delay crack generating marginal addition distortion deltaepsilon is shown. It turns out that 2000 micrometers or more high hydrogen delay crack generating marginal addition distortion deltaepsilon is stabilized, and is obtained by the maintenance for 2 seconds or more. In less than 2 seconds, since hardening distortion remains, 1900 micrometers or more high hydrogen delay crack generating marginal addition distortion

deltaepsilon is stabilized, and is not obtained.
[0027] Here with hydrogen delay crack generating marginal addition distortion deltaepsilon From an electroseamed steel pipe, cut down C-ring test piece with a width of face of 20mm, and bolting is performed to the outer diameter before logging. After adding distortion of the residual distortion of an electroseamed steel pipe, addition distortion further calculated by the formula (3) was added, it was immersed into 0.1-N hydrochloric acid for 200 hours, crack generating existence was investigated, and it asked for the addition distortion of the limitation which a crack generates, and considered as the index of a hydrogen-proof delay crack property. For the property of a hydrogen-proof delay crack, it is so desirable that this value is high.
[0028]
deltaepsilon=(4, 106, and t-delta)/(pi-D- (D-t)) (3)
For board thickness and D, at a formula (3), the outer diameter before logging and delta are [t] D. - (outer diameter after addition distortion addition)
Winding temperature: When it exceeds 150 degrees C, it does not become a hard tempering martensitic phase, but is 2 980Ns/mm. The above reinforcement is not obtained.
[0029] In manufacturing a high tension electroseamed steel pipe using the hot rolled sheet steel manufactured on the above conditions, the reason for definition of the tubulation condition is explained below.
[0030] Q/(t/D) 2 computed using width-of-face contraction percentage Q for which drawing 2 was asked from said formula (2) The relation of hydrogen delay crack generating marginal addition distortion deltaepsilon is shown. Q/2 (t/D) When a value is 3000 or less [1000 or more], 2000 micrometers or more high hydrogen delay crack generating marginal addition distortion deltaepsilon is stabilized, and it is ******. Q/2 (t/D) Since the deformation texture where it is strong at the time of tubulation when a value exceeds 3000 since residual distortion increases less than by 1000 and is formed, hydrogen crack sensitivity increases, and 1900 micrometers or more high hydrogen delay crack generating marginal addition distortion deltaepsilon is not obtained.
[0031] In addition to the steel component of the 1st invention, the 2nd invention according to claim 2 is wt%, and relates to the manufacture approach of a high tension electroseamed steel pipe excellent in the hydrogen-proof delay crack property characterized by performing the process after hot rolling by the same approach as the 1st invention using the slab by which the quality governing was carried out so that at least one or more of Nb:0.005-0.03 and V:0.005-0.03 sorts might be contained.
[0032] The reason for definition of Nb and the amount of V is explained below. Since each of Nb (s) and V makes the austenite grain before a transformation detailed and can carry out [detailed]-izing of the martensite packet after a transformation, it is an element desirable to improvement in a hydrogen-proof delay crack property. However, less than [0.005wt%], if there is little the effectiveness and it adds too much exceeding 0.03wt(s)%, a hydrogen-proof delay crack property will deteriorate on the contrary.
[0033] In addition to the steel component of the 1st invention or the 2nd invention, the 3rd invention according to claim 3 is wt%, and relates to the manufacture approach of a high tension electroseamed steel pipe excellent in the hydrogen-proof delay crack property characterized by performing the process after hot rolling by the same approach as the 1st invention using the slab by which the quality governing was carried out so that Cu:0.05-0.5 might be contained.
[0034] The reason for definition of the amount of Cu(s) is explained below. Since Cu controls trespass of the hydrogen to the inside of steel while controlling progress of the corrosion of steel, it raises a hydrogen-proof delay crack property. The relation between Cu addition and the variation of hydrogen crack generating marginal addition distortion deltaepsilon is shown in drawing 3 . Cu -- more than 0.05wt% -- by adding, the variation of hydrogen delay crack generating marginal addition distortion increases, and generating of a hydrogen delay crack is controlled. moreover, 0.5wt% -- since the effectiveness is saturated even if it exceeds and adds, the upper limit is made into 0.5wt(s)%.
[0035] In addition, an increment of the amount of Cu(s) may generate the surface discontinuity called Cu crack depending on the case. Although generating of Cu flaw can be prevented by

nickel addition, since nickel is an element harmful for a hydrogen-proof delay crack property, as for the addition, being restricted to less than [0.3wt%] is desirable.

[Translation done.]

* NOTICES *

EXAMPLE

[Example]
(Example 1) Steel A-E, the amount of C, and the amount of B which are the component system of this invention within the limits shown in a table 1 ingoted six sorts of steel of the steel F outside this invention range, and produced the electroseamed steel pipe of 34.0phix2.3mmt on the hot-rolling conditions and tubulation conditions of this invention within the limits shown in a table 2. And hydrogen delay crack generating marginal addition distortion deltaepsilon which is the tensile strength of a steel pipe and the above mentioned index of a hydrogen-proof delay crack property was measured.
[0037] A result is shown in a table 3. Each steel A-E which is the component system of this invention within the limits is 2 980Ns/mm. The above reinforcement is shown, and 2000 micrometers or more high hydrogen delay crack generating marginal addition distortion deltaepsilon is stabilized, and is obtained. Moreover, systematically, as shown in a table 2, it was 100% tempered martensite. On the other hand, although the steel F outside this invention range does not have a problem on reinforcement as for the amount of C, and the amount of B, hydrogen delay crack generating marginal addition distortion deltaepsilon is remarkably low, and a hydrogen-proof delay crack property is inferior.
[0038]
[A table 1]

鋼	化学成分(wt%、B と B* の単位は ppm)												備考
	C	Si	Mn	P	S	Al	Cr	N	Ti	B	B*	Others	
A	0.12	0.40	1.40	0.01	0.002	0.04	0.48	0.002	0.012	12	12	-	
B	0.15	0.41	1.51	0.01	0.002	0.03	0.41	0.002	0.000	22	5	0.22Cu	
C	0.15	0.41	1.55	0.01	0.002	0.03	0.47	0.002	0.009	8	8	0.010Nb	発明材
D	0.18	0.40	1.35	0.01	0.002	0.03	0.48	0.002	0.011	9	9	-	
E	0.18	0.39	1.30	0.01	0.002	0.03	0.44	0.002	0.008	11	11	0.27Cu	
F	0.23	0.40	1.82	0.01	0.002	0.03	0.02	0.003	0.000	0	0	-	比較材

[0039]
[A table 2]

鋼	番号	Ar3 温度 (℃)	熱延条件					造管条件				組織	備考
			仕上温度 (℃)	30%圧下温度 (℃)	冷却速度 ℃/s	保持時間 (s)	巻取温度 (℃)	板厚 t (mm)	外径 D (mm)	幅絞り率 Q(%)	Q/(t/D)²	焼戻しマルテンサイト分率 (%)	
A	1	820	910	935	120	2.1	90	2.3	34.0	6.5	1420	100	
B	2	810	910	940	110	2.2	90	2.3	34.0	6.5	1420	100	
C	3	810	890	915	115	2.5	70	2.3	34.0	6.5	1420	100	発明例
D	4	800	900	920	110	2.6	60	2.3	34.0	6.5	1420	100	
E	5	800	870	890	110	2.5	70	2.3	34.0	6.5	1420	100	
F	6	790	890	910	120	2.1	50	2.3	34.0	6.5	1420	100	比較例

[0040]
[A table 3]

鋼	番号	引張特性 TS (N/mm²)	耐水素遅れ割れ特性 割れ発生限界付加歪み.Δε(μm)	備考
A	1	1160	2140	発明例
B	2	1350	2860	
C	3	1370	2140	
D	4	1490	2140	
E	5	1490	2620	
F	6	1640	0	比較例

[0041] (Example 2) Various hot-rolling conditions as shown in a table 4, and tubulation conditions were changed using steel A-E of a table 1, and the electroseamed steel pipe was produced. And the tensile strength of a steel pipe and hydrogen delay crack generating marginal addition distortion deltaepsilon were measured.

[0042] A result is shown in a table 5. For the electroseamed steel pipe which has hot-rolling conditions and tubulation conditions in this invention within the limits, tensile strength is 2 980Ns/mm. And 2000 micrometers or more high hydrogen delay crack generating marginal addition distortion deltaepsilon is stabilized, and is obtained. Moreover, he was the complex tissue which consists of 80% or more of a tempered martensite and a ferrite systematically as shown in a table 4. On the other hand, hot-rolling conditions and tubulation conditions were not insufficient for tensile strength by the sample outside this invention range, and hydrogen delay crack generating marginal addition distortion deltaepsilon was not so so high as 950 micrometers, and it was stabilized and the value of deltaepsilon was not acquired.

[0043]

[A table 4]

鋼	番号	Ar3温度(℃)	熱延条件 仕上温度(℃)	.30%圧下温度(℃)	冷却速度℃/s	保持時間(s)	巻取温度(℃)	造管条件 板厚t(mm)	外径D(mm)	幅絞り率Q(%)	Q/(t/D)²	組織 焼戻しﾏﾙﾃﾝｻｲﾄ分率(%)	備考
A	7	820	840	865	80	2.1	90	2.3	38.1	3.9	1070	85	発明例
	8		900	930	110	2.4	60	2.3	31.8	8.2	1568	100	
	9		890	915	50	2.4	70	2.3	38.1	3.9	1070	60	比較例
	10		910	930	110	2.2	80	2.3	31.8	4.8	918	100	
B	11	810	850	880	100	2.5	80	3.2	31.8	11.8	1165	100	発明例
	12		870	885	115	2.3	80	2.3	34.0	10.5	2295	100	
	13		880	900	100	2.4	70	3.2	38.1	7.5	1063	100	
	14		820	840	100	2.1	90	2.3	38.1	3.9	1070	70	比較例
	15		930	950	120	2.0	90	2.3	31.8	8.2	1568	100	
C	16	810	850	875	110	2.6	80	2.3	38.1	3.9	1070	100	発明例
	17		860	880	105	3.0	90	3.2	31.8	11.8	1165	100	
	18		870	990	105	2.9	60	2.3	38.1	11.8	3238	100	比較例
	19		870	885	100	>2.0	180	3.2	31.8	11.8	1165	*1	
D	20	800	860	890	110	2.8	80	2.3	38.1	3.9	1070	100	発明例
	21		900	920	110	2.8	80	2.0	34.0	9.5	2746	100	
	22		870	890	115	2.8	70	2.0	34.0	6.5	1879	100	
	23		880	900	110	2.3	80	2.3	31.8	8.2	1568	100	
	24		890	915	90	1.3	60	2.3	38.1	3.9	1070	*2	比較例
	25		900	950	100	2.3	70	2.0	34.0	6.5	1879	100	
	26		900	920	90	2.2	70	2.0	38.1	9.6	3484	100	
E	27	800	900	925	120	2.2	60	2.3	34.0	6.5	1420	100	発明例
	28		850	880	105	2.1	80	2.0	31.8	7.2	1820	100	
	29		860	880	105	1.3	80	2.0	34.0	6.5	1879	*2	比較例
	30		840	865	90	2.2	100	2.3	31.8	3.9	746	100	

*1：ﾍﾞｲﾅｲﾄ100% *2:焼入れまままﾏﾙﾃﾝｻｲﾄ100%

[0044]

[A table 5]

鋼	番号	引張特性 TS (N/mm²)	耐水素遅れ割れ特性 割れ発生限界付加歪み Δε(μm)	備考
A	7	1030	2140	発明例
	8	1190	2140	
	9	830	2140	比較例
	10	1150	950	
B	11	1360	2860	発明例
	12	1390	2860	
	13	1340	2860	
	14	880	2860	比較例
	15	1360	950	
C	16	1310	2140	発明例
	17	1350	2140	
	18	1380	950	比較例
	19	950	2140	
D	20	1490	2140	発明例
	21	1480	2140	
	22	1500	2140	
	23	1500	2140	
	24	1490	950	比較例
	25	1510	950	
	26	1550	950	
E	27	1480	2620	発明例
	28	1510	2620	
	29	1530	950	比較例
	30	1490	950	

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is drawing showing the relation of the holding time and hydrogen delay crack generating marginal addition distortion deltaepsilon in a 150-250-degree C temperature requirement.
[Drawing 2] Q/2 (t/D) It is drawing showing the relation of hydrogen delay crack generating marginal addition distortion deltaepsilon.
[Drawing 3] It is drawing showing the relation between Cu addition and the variation of crack generating marginal addition distortion deltaepsilon.

[Translation done.]

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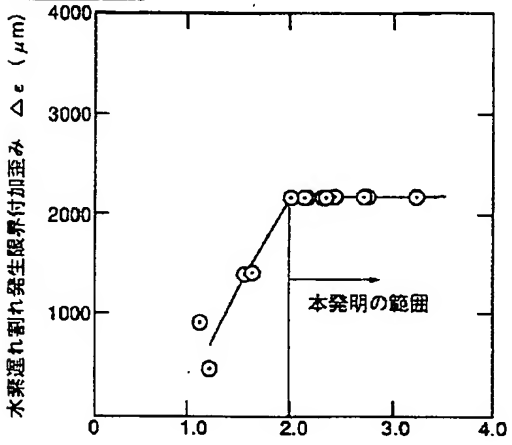
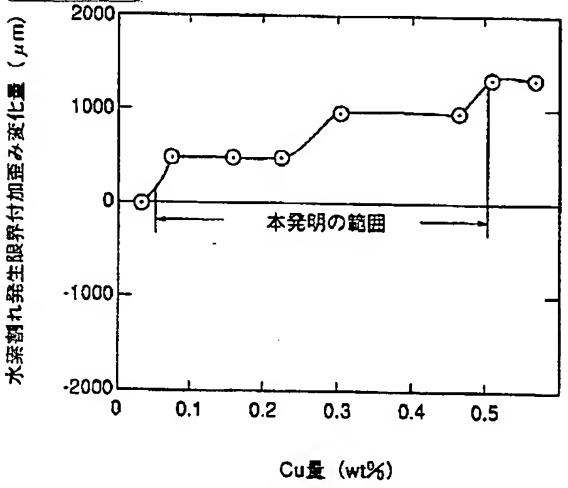
DRAWINGS

[Drawing 1]



[Drawing 3]



[Drawing 2]